Claims

1. A microcapsule, comprising charged particles of one or more colors suspended in a phase change material that has a melting temperature in the range of between about 30°C and about 200°C, wherein particles of at least one color have a charge.

2. The microcapsules of Claim 1, wherein the microcapsule comprises particles having at least two colors, wherein particles having one or more colors have a positive charge and particles having one or more different colors have a negative charge.

3. The microcapsules of Claim 1, wherein the particles have two colors and one color particle has a positive charge and the other color particle has a negative charge.

4. The microcapsule of Claim 3, wherein some of the particles are black and the rest of the particles are white, and wherein the black particles have a positive charge and the white particles have a negative charge or the black particles have a negative charge and the white particles have a positive charge.

5. The microcapsules of Claim 1, wherein the particles have three colors and the particles of each color have a substantially different electrophoretic mobility.

6. The microcapsules of Claim 1, wherein the particles are red, green and blue.

7. The microcapsules of Claim 1, wherein the particles are cyan, yellow and magenta.

8. The microcapsule of Claim 1, wherein substantially all the particles have a positive charge or substantially all the particles have a negative charge, and wherein the phase change material is not transparent when it is a solid.

9. The microcapsules of Claim 7, wherein a dye is dispersed throughout the phase change material.

10. The microcapsules of Claim 1, wherein the particles have two colors and each colored particle has a different electrophoretic mobility, and wherein the phase change material is not transparent when it is a solid.

11. The microcapsules of Claim 10, wherein a dye is dispersed throughout the phase change material.

12. The microcapsule of Claim 1, wherein the phase change material has a melting point in the range of between about 60°C and about 100°C.

13. The microcapsule of Claim 12, wherein the phase change material is selected from the group consisting of paraffin wax, 1-docosanol, 1-hexacosanol, n-tetratetracontane, 1-triacontanol, and n-pencontane.

14. The microcapsule of Claim 1, wherein the particles are coated with a surfactant.

15. The microcapsule of Claim 1, further comprising an optically transparent polymeric material encapsulating the microcapsule.

16. The microcapsule of Claim 1, further comprising a material that absorbs infrared radiation dispersed through out the phase change material.

17. The microcapsule of Claim 16, wherein the material that absorbs infrared radiation is 2-[2-[2-chloro-3-[(1,3-dihydro-3,3-dimethyl-1-propyl-2H-indol-2-ylidene)ethylidene]-1-cyclohexen-1-yl]ethenyl]-3,3-dimethyl-1-propylindolium iodide .

18. A rewritable medium for visual display, comprising an electrophoretic coating on a substrate, wherein the electrophoretic coating comprises:

a) microcapsules, comprising charged particles of one or more colors suspended in a phase change material that has a melting temperature in the range of between about 30°C and about 200°C, wherein particles of at least one color have a positive or a negative charge; and

b) a polymer matrix, wherein the microcapsules are distributed in the polymer matrix.

19. The rewritable medium of Claim 18, wherein the microcapsule comprises particles having at least two colors, wherein particles having one or more colors have a positive charged and particles having one or more different colors have a negative charge.

20. The rewritable medium of Claim 19, wherein the particles have two colors and one color particle has a positive charge and the other color particle has a negative charge.

21. The rewritable medium of Claim 20, wherein some of the particles are black and the rest of the particles are white, and wherein the black particles have a positive charge and the white particles have a negative charge or the black particles have a negative charge and the white particles have a positive charge.

22. The rewritable medium of Claim 18, wherein the particles have three colors and the particles of each color have a substantially different

electrophoretic mobility.

23. The rewritable medium of Claim 22, wherein the particles are red, green and blue.

24. The rewritable medium of Claim 18, wherein substantially all the particles have a positive charge or substantially all the particles have a negative charge, and wherein the phase change material is not transparent when it is a solid.

25. The rewritable medium of Claim 24, wherein a dye is dispersed throughout the phase change material.

26. The rewritable medium of Claim 18, wherein the particles have two colors and the particles of each color have a different electrophoretic mobility, and wherein the phase change material is not transparent when it is a solid.

27. The rewritable medium of Claim 26, wherein a dye is dispersed throughout the phase change material.

28. The rewritable medium of Claim 18, further comprising a metal layer between the substrate and the electrophoretic coating.

29. The rewritable medium of Claim 28, wherein the metal layer is reflective.

30. The rewritable medium of Claim 18, wherein the substrate is plastic.

31. The rewritable medium of Claim 30, wherein the substrate is a polycarbonate disc.

32. The rewritable medium of Claim 18, wherein the substrate is paper.

33. The rewritable medium of Claim 18, wherein the microcapsules are distributed substantially uniformly in the polymer matrix.

34. The rewritable medium of Claim 18, wherein the polymer matrix is a polymer that is curable using ultraviolet light.

35. The rewritable medium of Claim 18, further comprising a optically transparent protective layer over the electrophoretic coating.

36. The rewritable medium of Claim 18, wherein the phase change material has a melting point in the range of between about 60°C and about 100°C.

37. The rewritable medium of Claim 18, wherein the phase change material is selected from the group consisting of paraffin wax, 1-docosanol, 1-hexacosanol, n-tetratetracontane, 1-triacontanol, and n-pencontane.

38. The rewritable medium of Claim 18, wherein the particles are coated with a surfactant.

39. The rewritable medium of Claim 18, further comprising an optically transparent polymeric material encapsulating the microcapsule.

40. The rewritable medium of Claim 18, further comprising a material that absorbs infrared radiation dispersed through out the phase change material.

41. The rewritable medium of Claim 40, wherein the material that absorbs infrared radiation is 2-[2-[2-chloro-3-[(1,3-dihydro-3,3-dimethyl-1-propyl-2H-indol-2-ylidene)ethylidene]-1-cyclohexen-1-yl]ethenyl]-3,3-dimethyl-1-propylindolium iodide .

42. A method of forming or erasing an image on a rewritable medium of Claim 18, comprising the steps of:

a) heating a first section of the electrophoretic coating that comprises one or more picture elements, thereby liquefying the phase change material in the first section;

b) applying a directional electric field to each picture element of the heated section, thereby causing the charged particles in the liquefied phase change material to migrate;

c) allowing the first section of the electrophoretic medium to cool, thereby solidifying the phase change material in the first section; and

d) optionally repeating steps a) through c) at one or more different sections of the electrophoretic coating.

43. The method of Claim 42, wherein the electric field is applied in a direction perpendicular to the surface of the electrophoretic coating, thereby causing the charged particles to migrate towards the surface of the electrophoretic coating or away from the surface of the electrophoretic coating.

44. The method of Claim 43, wherein an image is formed by applying the electric field to at least one picture element of the electrophoretic coating in the opposite direction from the electric field applied in at least one other picture element of the electrophoretic coating.

45. The method of Claim 42, wherein an image is erased by applying an electric field in the same direction in all picture elements of the electrophoretic coating.

46. The method of Claim 42, wherein a material that absorbs infrared radiation is dispersed throughout the phase change material.

47. The method of Claim 46, wherein the section of the electrophoretic coating is heated with an infrared laser or an infrared lamp.

48. The method of Claim 42, wherein the section of the electrophoretic coating is heated by radio frequency (RF) induction or microwave impingement.

49. The method of Claim 42, wherein the rewritable medium further comprises a metal layer between the substrate and the electrophoretic coating.

50. The method of Claim 49, wherein the electric field is generated by applying a potential difference between the metal layer and a point source on the opposite side of the electrophoretic coat as the metal layer.

51. The method of Claim 50, wherein the substrate is a polycarbonate disc.

52. The method of Claim 42, wherein the electric field is generated by two metal plates connected to a power source, wherein one plate is placed below the electrophoretic medium and the other metal plate is placed above the electrophoretic medium.

53. The method of Claim 52, wherein the substrate is paper.

54. The method of Claim 42, wherein the electric field is applied simultaneously by a line of electrode pairs to a row of picture elements, wherein one electrode of each electrode pair is placed below the rewritable medium and the other electrode of the electrode pair is placed above the rewritable medium.

55. The method of Claim 42, wherein the electric field is applied simultaneously by three lines of electrode pairs to three rows of picture

elements, wherein one electrode of each electrode pair is placed below the rewritable medium and the other electrode of the electrode pair is placed above the rewritable medium.

56. The method of Claim 42, wherein:

a) the microcapsules have three colored particles, wherein the particles of each color have a different electrophoretic mobility; and

b) in one or more picture elements, the electric field is applied in one direction for a period of time and then applied to the same picture element in the opposite direction for a different period of time, thereby forming a colored image.

57. The method of Claim 56, wherein the electric field is applied in a direction that is perpendicular to the surface of the electrophoretic coating.

58. The method of Claim 42, wherein the section of the electrophoretic material is cooled to solidify the phase change material by removing the heat source.

59. The method of Claim 42, wherein the microcapsule comprises particles having at least two colors, wherein particles having one or more colors have a positive charged and particles having one or more different colors have a negative charge, and wherein the electric field is applied in a direction perpendicular to the surface of the electrophoretic coating, thereby causing at least a portion of the charged particle to migrate towards the surface of the electrophoretic coating and the rest of the particles to migrate away from the surface of the electrophoretic coating.

60. The method of Claim 42, wherein:

a) substantially all the particles have a positive charge or substantially all the particles have a negative charge;

b) the phase change material is not transparent when it is a solid; and

c) the electric field is applied to each picture element in a direction perpendicular to the surface of the electrophoretic coating, thereby causing substantially all the charged particles in the picture element to migrate towards the surface of the electrophoretic coating or substantially all the charged particles to migrate away from the surface of the electrophoretic coating.

61. An apparatus for forming or erasing an image on the rewritable medium of Claim 18, comprising:

a) a heating element;

b) at least one electrode;

c) a means for positioning the heating element to heat a section of the electrophoretic coating; and

d) a means for positioning the at least one electrode above the surface of the section of the electrophoretic coating.

62. The apparatus of Claim 61, wherein the at least one electrode is positioned above the surface of a section of the electrophoretic medium that is simultaneously heated by the heating element.

63. The apparatus of Claim 61, wherein the heating element is positioned to heat a section of the electophoretic medium before the at least one electrode is positioned above the surface of said section of the electrophoretic coating.

64. The apparatus of Claim 61, wherein the heating element is an infrared laser, an infrared lamp, an RF induction heater, or a microwave heating device.

65. The apparatus of Claim 61, wherein the rewritable medium includes a

metal layer between the electrophoretic coating and the substrate; and the apparatus further comprises a power source connected to the electrode and the metal layer.

66. The apparatus of Claim 61, wherein the apparatus comprises at least two electrodes each comprising a metal plate connected to a power supply, wherein one metal plate is placed above the surface of the electrophoretic coating and the other electrode is placed on the opposite side of the electrophoretic coating.

67. The apparatus of Claim 61, comprising a line of electrode pairs, wherein one electrode of an electrode pair is placed below the rewritable medium and the other electrode of the electrode pair is placed above the rewritable medium.

68. The apparatus of Claim 61, comprising three parallel lines of electrode pairs, wherein one electrode of an electrode pair is placed below the rewritable medium and the other electrode of the electrode pair is placed above the rewritable medium.

69. The apparatus of Claim 61, wherein the means for positioning the heater and the means for positioning the electrode is a means for moving the rewritable medium.

70. The apparatus of Claim 69, wherein the substrate is a polycarbonate disc and the means for moving the rewritable medium is a drive ring which moves the disc.

71. The apparatus of Claim 69, wherein the substrate is paper and the means for moving the rewritable medium is a transport roller.

72. The apparatus of Claim 67 or 68, wherein the means for positioning the

heater and the electrode is a device that moves the heater and the electrodes horizontally or vertically over the rewritable medium.